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(NASA-CR-164295) USER'S MANUAL FOR FLIGHT
SIMULATOR DISPLAY SYSTEM (FSDS) (Gjerding
(B. K.) Simulation Electronics) 14 p
HC A 02/MF A 01

N81-23095

CSSL 14B

G3/09

Unclas
24124

USER'S MANUAL
FOR
FLIGHT SIMULATOR DISPLAY SYSTEM
11/18/79

by
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Prepared Under Contract Number NAS2-9434

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1.0 INTRODUCTION

Information on the Flight Simulator Display System (FSDS) is presented in three (3) volumes:

- I. User's Manual
- II. Programmer's Manual
- III. Hardware Maintenance Manual

This is Volume I in the series, and is an attempt to describe the capabilities of the FSDS (in general terms whenever possible). Much of what is done with the FSDS is programmable; thus, limitations are often those of the user's imagination.

Detailed information on exactly how the FSDS is programmed to perform a desired task is given in the "FSDS Programmer's Reference Manual"; while the "FSDS Maintenance Manual" contains detailed information on how the FSDS operates. A user who needs information beyond that presented here should refer to the Programmer's Manual.

The Flight Simulator Display System is a color raster-scan display generator designed to meet the special needs of Flight Simulation laboratories, and others needing a versatile CRT display system. Figure 1-0 shows the interconnections between the FSDS and other systems in a typical simulation facility.

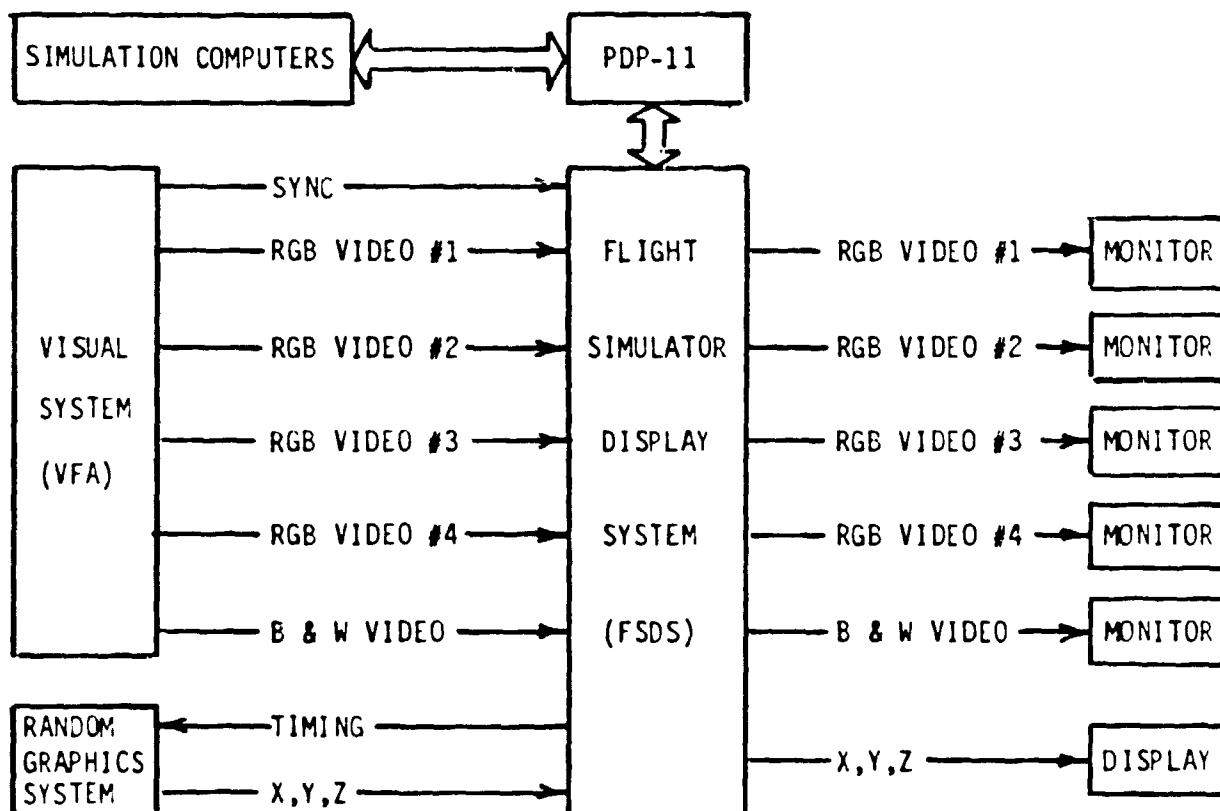


FIGURE 1-0 THE FSDS IN A SIMULATION FACILITY

The FSDS can update (revise) the images it generates every 16.6mS, with limited support from a host processor. This corresponds to the standard TV vertical rate of 60 Hertz, and allows the system to carry out display functions in a time critical environment. The most unique of these functions is the rotation of a complex image in the television raster with minimal hardware.

2.0 DISPLAY SYSTEM CAPABILITIES

The FSDS contains both Analog and Digital symbol generator circuits which drive four color (RGB) video channels and one Black and White video channel. In addition, the Black and White video channel can be multiplexed with stroke-written symbols on a hybrid display (Figure 2-0).

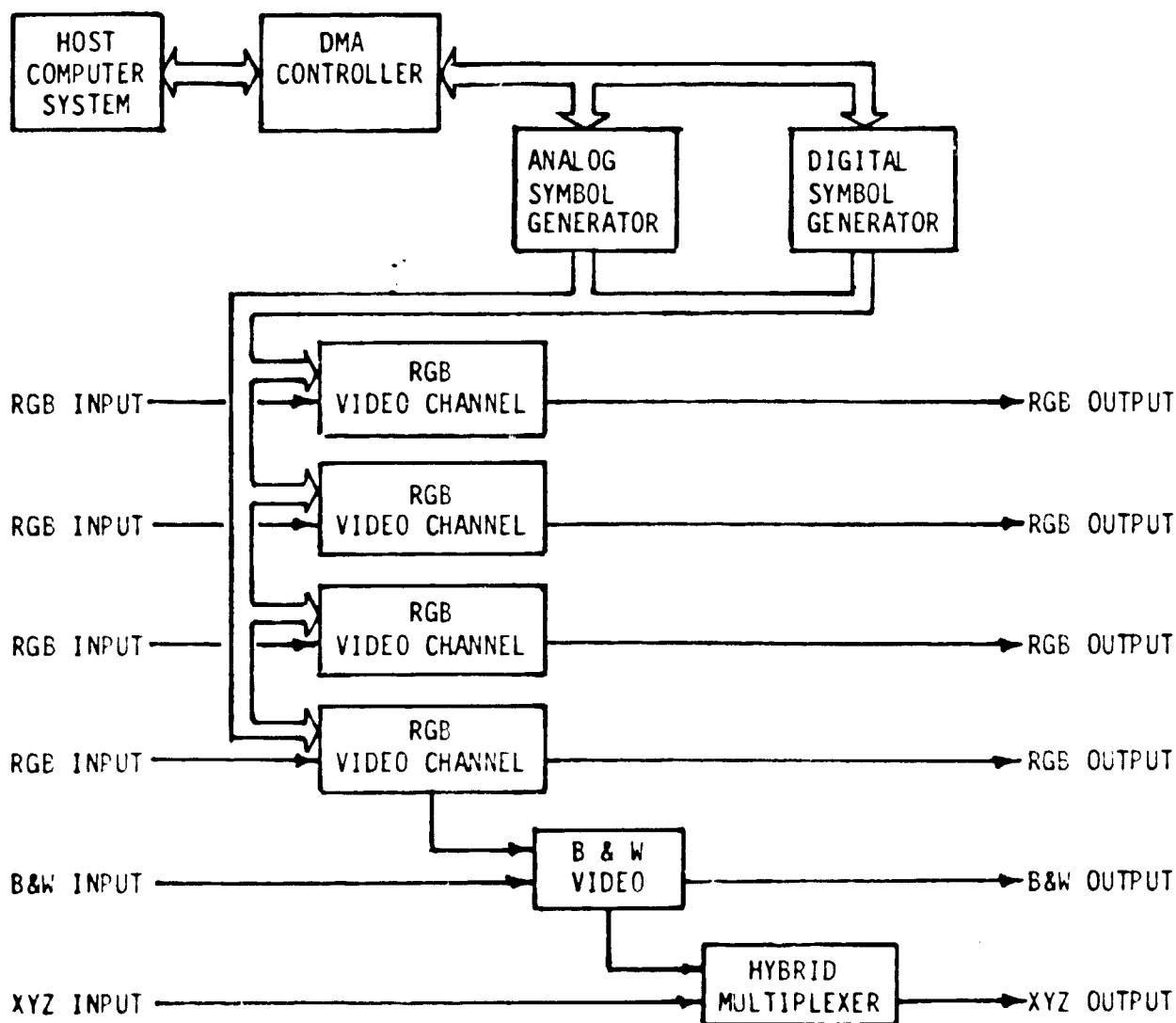


FIGURE 2-0 FSDS BLOCK DIAGRAM

The raster graphics generated by the FSDS can be visualized as consisting of up to eight transparent overlays containing opaque colored images placed in front of a TV background (Figure 2-1).

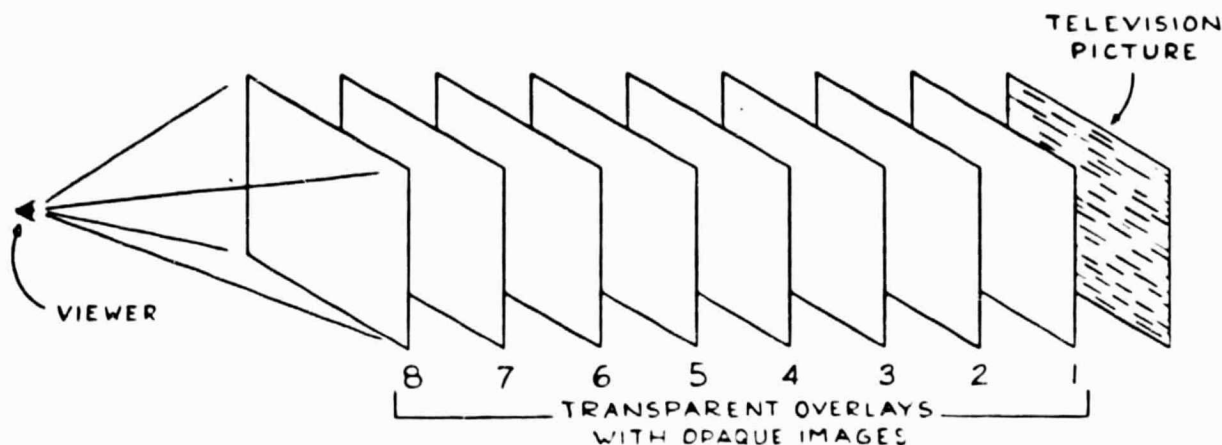


FIGURE 2-1

Thirty-six symbols (defined in section 3) can be combined to form the images on the various overlays. Symbol selection is independent for each video channel.

The overlays are assigned colors independently, with all symbols of a given overlay having the same color. There are 64 colors available as shown in Figure 2-2.

When image-filled overlays are superimposed, many different effects can be obtained. As a simplified example, consider the three overlays shown in Figure 2-3.

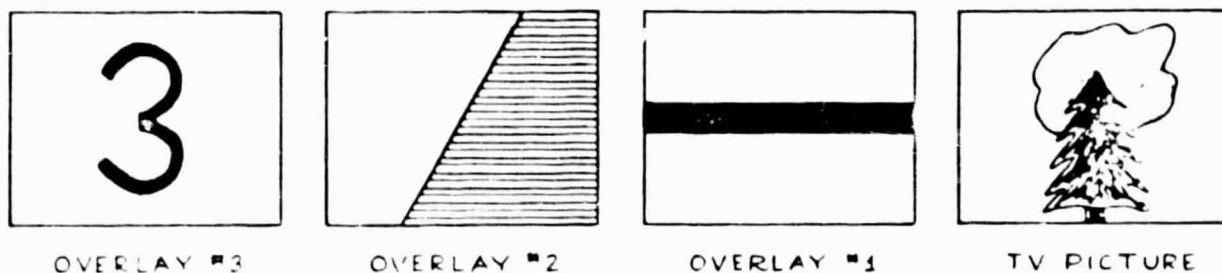


FIGURE 2-3

Superimposing these yields the composite shown in Figure 2-4. Notice how overlay #2 covers the right side of both the TV background and overlay #1, while overlay #3 masks portions of all "lower layer" images.



FIGURE 2-4

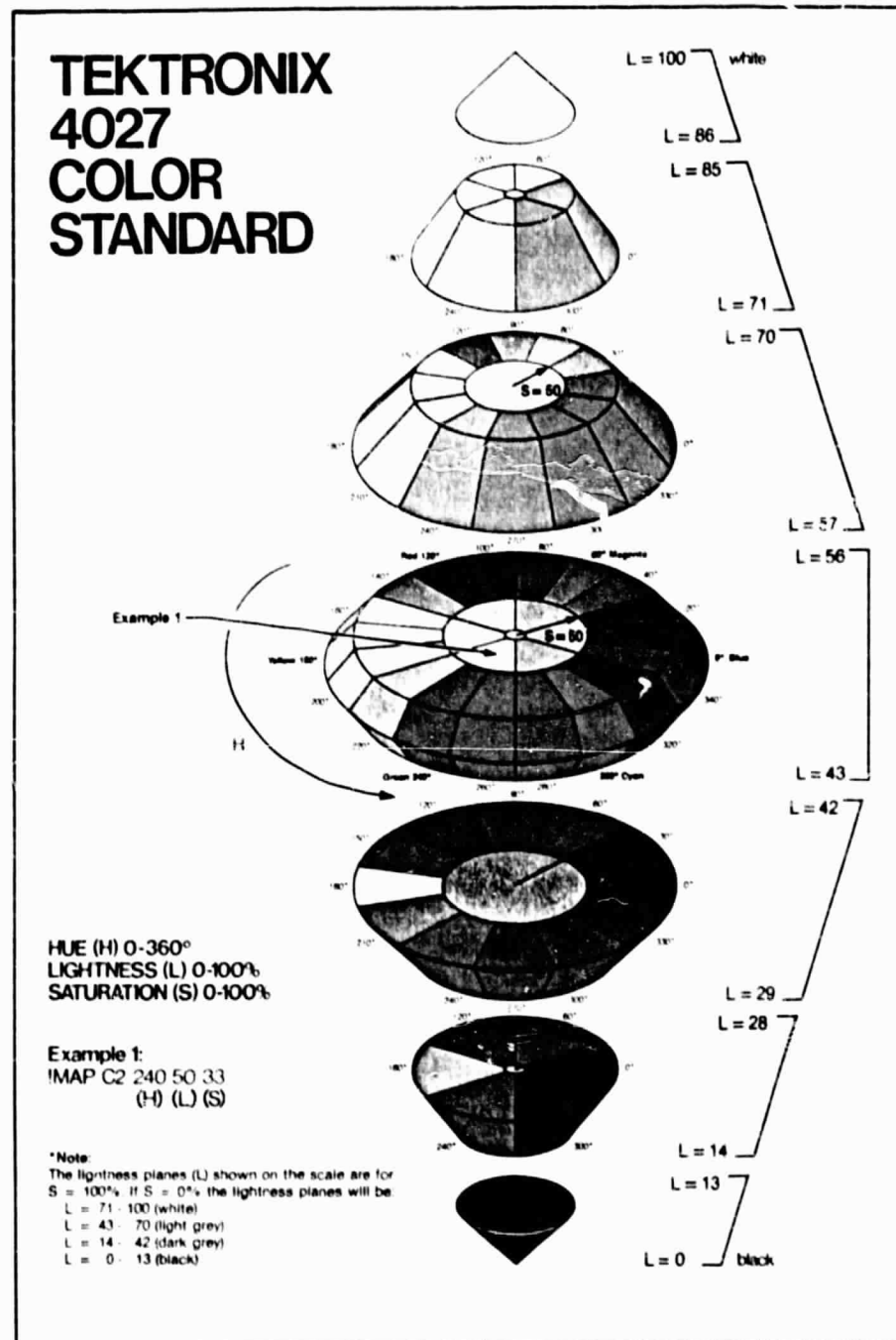


Illustration (c) Tektronix, Inc. Used by Permission.

FIGURE 2-2 AVAILABLE FSDS COLORS

Extending this technique to eight levels allows complex graphic images to be generated.

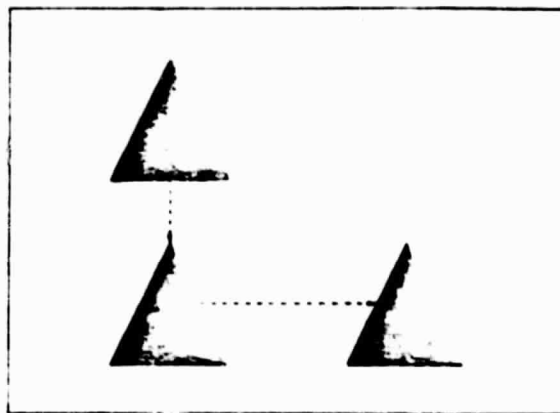
If no television background is desired, a full-raster "symbol" can provide a constant color background for the display.

3.0 SYMBOLS

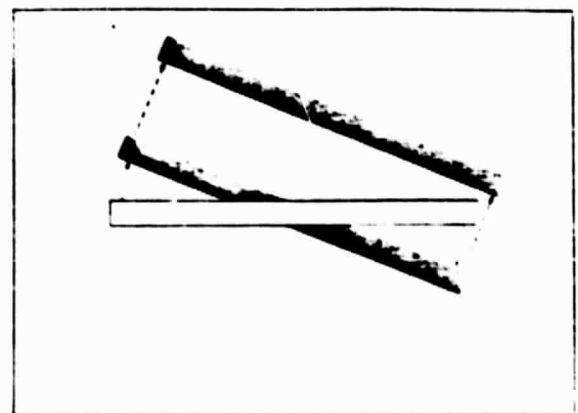
Two different classes of symbols are generated by the FSDS:

1. symbols which are either a) fixed in the TV raster, or b) move only parallel or perpendicular to the raster lines (CRT bezel). (Figure 3-1).
2. symbols which can both a) rotate with respect to the raster lines, and b) move anywhere on the CRT. (Figure 3-2).

Logically enough, the first class of symbols is termed "non-rotating" symbols, and the second class, "rotating" symbols.



NON-ROTATING SYMBOLS



ROTATING SYMBOLS

FIGURE 3-1

3.1 Non-Rotating (Digital) Symbols

Up to 24 symbols of this class may be generated simultaneously by the FSDS. These symbols can be of the following two types:

- * Programmable Symbols
- * Alpha-Numerics

Additional types can be developed to meet special needs.

Up to 6 modules (digital symbol generating cards) of these two types may be used at any one time.

3.1.1 Programmable Symbols Module

A Programmable Symbol can be as simple as a rectangle (of any size), or as complex as any possible pattern in a 64 line by 128 column array. (Figure 3-1-1A).

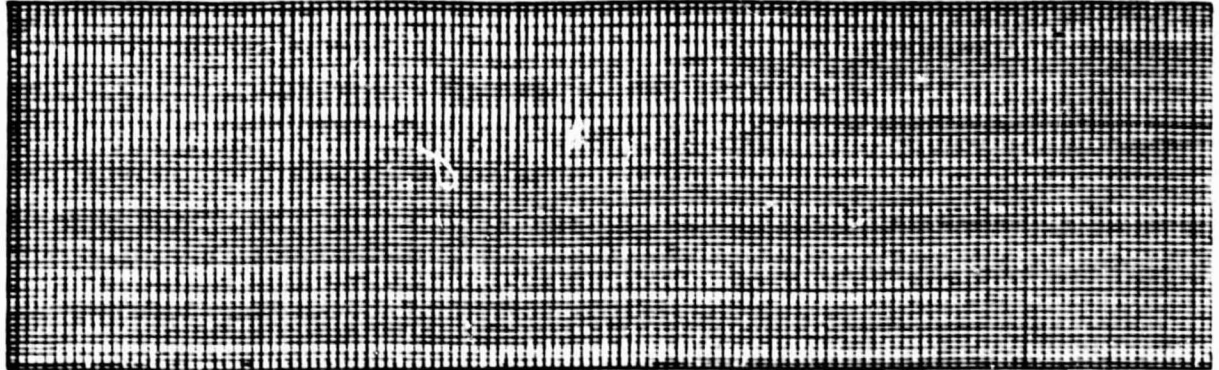


FIGURE 3-1-1A PROGRAMMABLE SYMBOLS PATTERN ARRAY

For each Programmable Symbol, 4 different representations or patterns can be stored and dynamically selected by the host processor for display. The pattern in the array is defined using the Programmable Symbol Development Aid. (Details on operating this unit can be found in Appendix 3 of the FSIDS Programmer's Manual.)

A Programmable Symbol can be placed anywhere on the raster and positioned with a horizontal resolution of $1/376$, and a vertical resolution of $1/240$. (There are 240 pairs of visible raster lines in a standard 525 line TV system.)

A Programmable Symbol can be drawn in the 64 X 128 array (or its size defined) with a horizontal resolution of $1/188$, and a vertical resolution of $1/240$. (The horizontal resolution is sacrificed by a factor of two, allowing the symbols to be twice as wide, as shown in Figure 3-1-1B.)

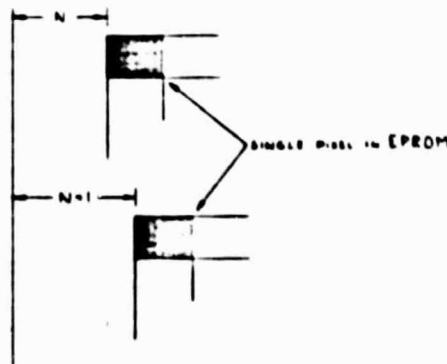


FIGURE 3-1-1B PROGRAMMABLE SYMBOL PATTERN RESOLUTION

3.1.2 Alpha-Numerics Module

Each module is capable of generating 16 rows of 46 ASCII characters. There are 64 characters available (upper case letters, numbers 0-9, and common punctuation symbols). Each consists of a 7 X 9 dot matrix in a 9 X 12 field. The 9 X 12 field can be used as an "underlay" symbol to insure sufficient visual contrast between the character and its background.

Identical messages may be displayed on multiple outputs simultaneously, or different messages may be displayed on each output. In the latter case, however, the messages must be placed at different locations.

3.2 Rotating (Analog) Symbols

Rotating symbols are those which can rotate (or "roll") through 360 degrees relative to the raster lines, as well as move anywhere in the raster. Up to 12 symbols of this class may be displayed simultaneously on each output.

These symbols are rolled around a reference point called the "roll center", which has two selectable locations: 1) the center of the screen, 2) mid-way between the screen center and top. These positions are fixed in hardware. (Each set of rotating symbols can be assigned a roll-center independently.)

Since rotating symbols are defined in hardware, they are more difficult to modify. However, limited changes (such as size) can be easily accomplished by referring to data in the Programmer's Reference Manual.

The following example details Analog symbols as used in an aircraft Attitude-type display in an effort to demonstrate their capabilities.

Typical symbol groups of such a display might include:

- * Pitch Tape
- * Roll Pointer
- * Velocity Vector
- * Other, Special Symbols

3.2.1 Pitch Tape

This group is composed of:

- * Horizon line - a line designating "zero" pitch attitude
- * Sky - the shading or background above the horizon line
- * Ground - the shading or background below the horizon line
- * Pitch lines - lines representing various pitch angles (typically 5, 10, 15, 20 degrees positive, and 5, and 10 degrees negative)

As previously indicated, these symbols form a group which can be rotated (rolled) 360 degrees, as well as pitched (perpendicular movement with respect to the angle of roll). See Figure 3-2-1.

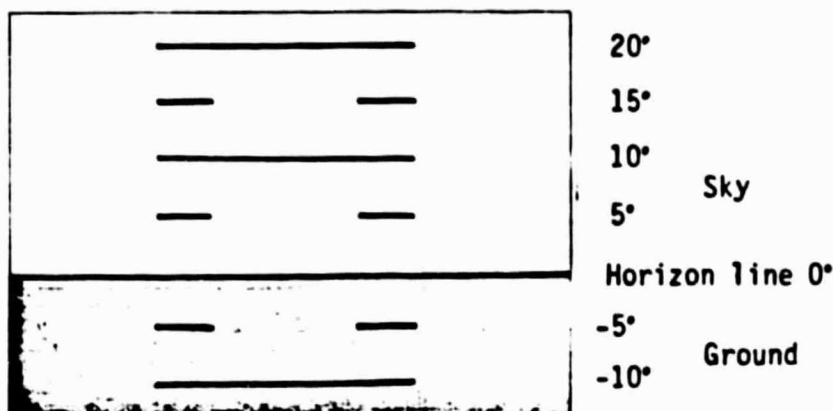


FIGURE 3-2-1 PITCH TAPE

3.2.2 Roll Pointer

The roll pointer is a rectangular bar used to indicate the roll-angle. It rotates with the pitch tape, and is always perpendicular to the horizon line. The roll pointer can be placed at either the top of the display (as a sky pointer) or the bottom of the display (for a ground pointer) under program control. (Figure 3-2-2).

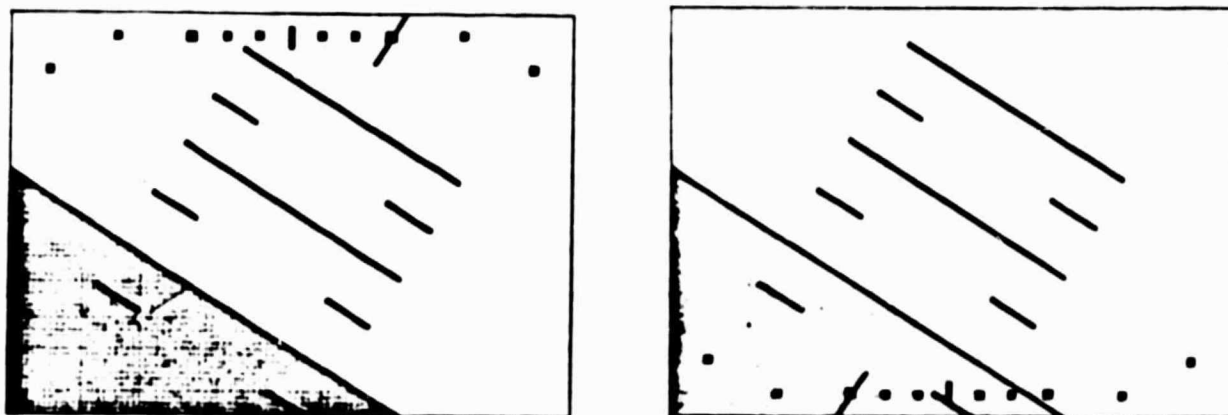
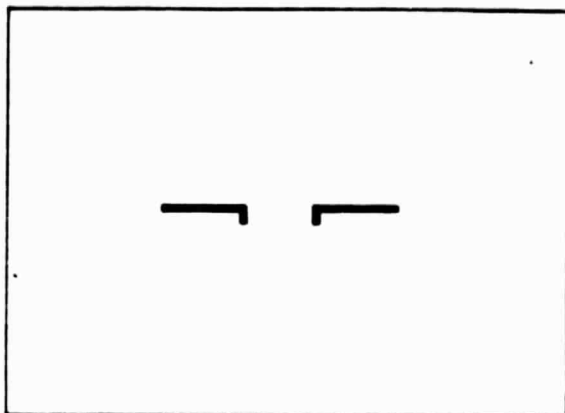
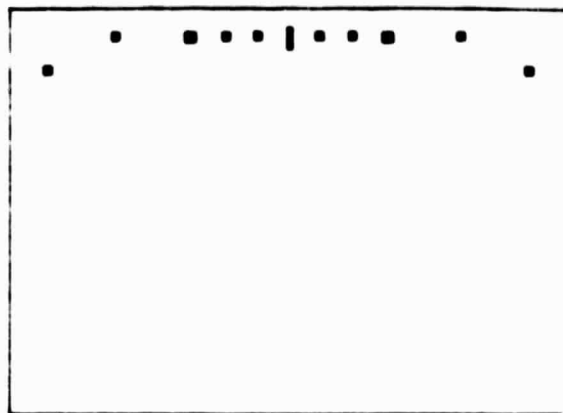


FIGURE 3-2-2 SKY AND GROUND ROLL POINTERS

Programmable Symbols can be used as fixed reference symbols for rotating symbology. The examples shown in Figure 3-2-2 are the airplane reference symbol, and roll index marks. The airplane reference symbol acts as both a pitch and roll reference mark. The roll index is a set of calibrated marks at the screen edge forming a reference scale for the roll pointer. As the display is rotated the roll pointer moves and the angle can be read on the roll index.



AIRPLANE REFERENCE SYMBOL



ROLL INDEX MARKS

FIGURE 3-2-2

3.2.3 Velocity Vector

The symbols which make up this group are:

- * Flight path - a symbol indicating the direction of the airplane velocity vector
- * Flight path acceleration - a symbol which is referenced to the flight path symbol
- * Pitch reference line - a line parallel to the horizon which can be placed at any desired angle

The flight path symbol is referenced to the horizon line. An airplane in level flight would have its flight path symbol on the horizon line.

When the flight path acceleration symbol is above the flight path symbol the airplane is accelerating at a rate indicated by the distance between the two symbols vertically. When the flight path acceleration symbol is below the flight path symbol, the plane is decelerating at a rate proportional to the vertical difference between the two symbols.

These symbols as a group (Figure 3-2-3) can shift horizontally to display drift angle.

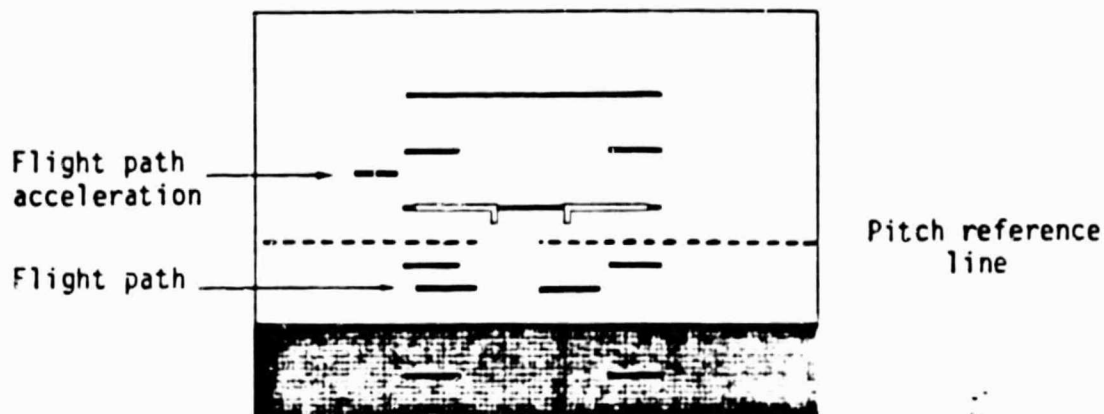


FIGURE 3-2-3 FLIGHT PATH SYMBOLOGY

3.2.4 Special Rotating Symbols

Special rotating symbols have been created in hardware to solve specific problems. Existing symbols include:

3.2.4.1 Ground Texture

An adaptation of the Pitch Tape circuitry was used to implement the quasi-random "ground texture" pattern shown in Figure 3-2-4-1.

The pattern shown rolls and pitches in a manner identical to (but independent of) the Pitch Tape. The quasi-random breaks in the "horizontal" texture lines can be moved (both left and right) at rates which simulate velocity.

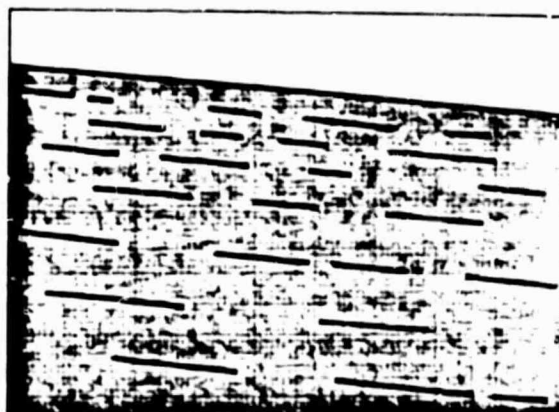


FIGURE 3-2-4-1 GROUND TEXTURE

3.2.4.2 Bi-Plane Flight Director

This symbol (Figure 3-2-4-2) rolls around its assigned roll-center and pitches. As the name suggests, it is used in conjunction with the airplane reference symbol. This is not a standard symbol on the FSDS.

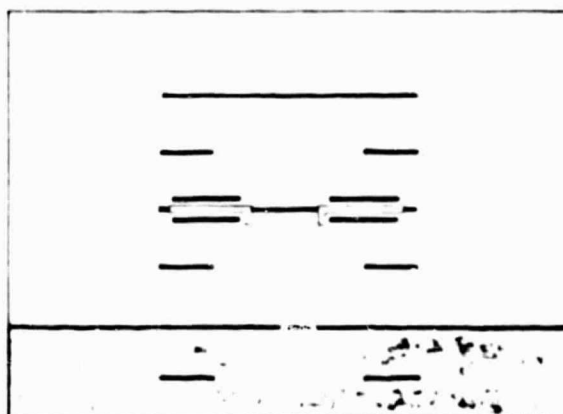


FIGURE 3-2-4-2 BI-PLANE FLIGHT DIRECTOR

3.2.4.3 Rolling Deviation Window

This symbol (Figure 3-2-4-3) can also be rolled and pitched. Its size is alterable under program control. The tail is superimposed with a 5 part variable scale which can be read as the tail is lengthened or shortened. This is not a standard symbol on the FSDS.

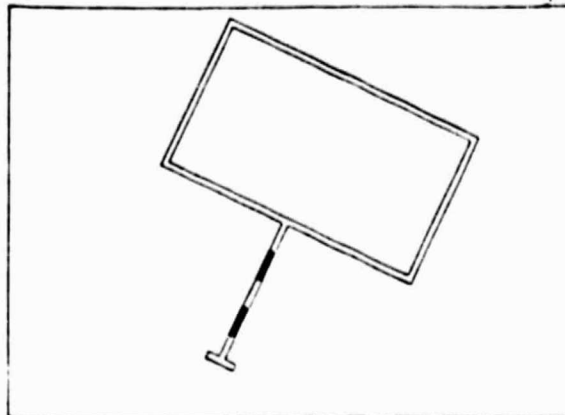


FIGURE 3-2-4-3 ROLLING DEVIATION WINDOW

4.0 CONCLUSION

To review: the FSDS can produce up to 24 Non-rotating symbols (Programmable Symbols and/or Alpha-Numerics) at any time, as well as up to 12 Rotating symbols on each output. A total of 36 symbols can be superimposed on a television background in 8 (of 64 available) colors on each output. In addition to 4 color output channels, a Black and White output channel and Hybrid (Raster/Stroke) channel are also available. Appendix I shows snapshots of typical initialized displays on the 4 color video channels of the FSDS, and should give a practical idea of possible uses.

The FSDS, with its many capabilities, invites the challenge of new applications. The wide parameters governing symbol definition allow the FSDS to be tailored to meet the user's needs with relative ease. Its versatility encourages imagination and enterprise.

BK Gjerding Electronics is always available for consultation regarding specific applications which might use the FSDS in its current or an enhanced configuration.

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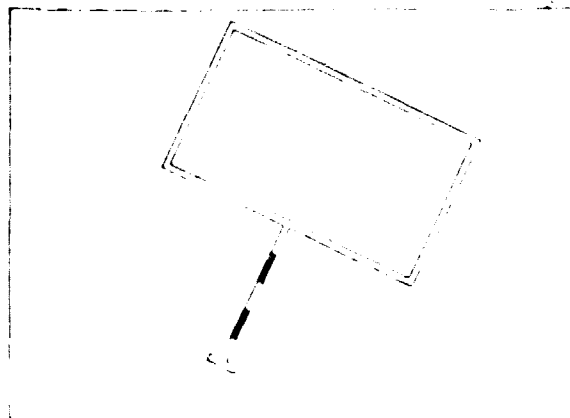


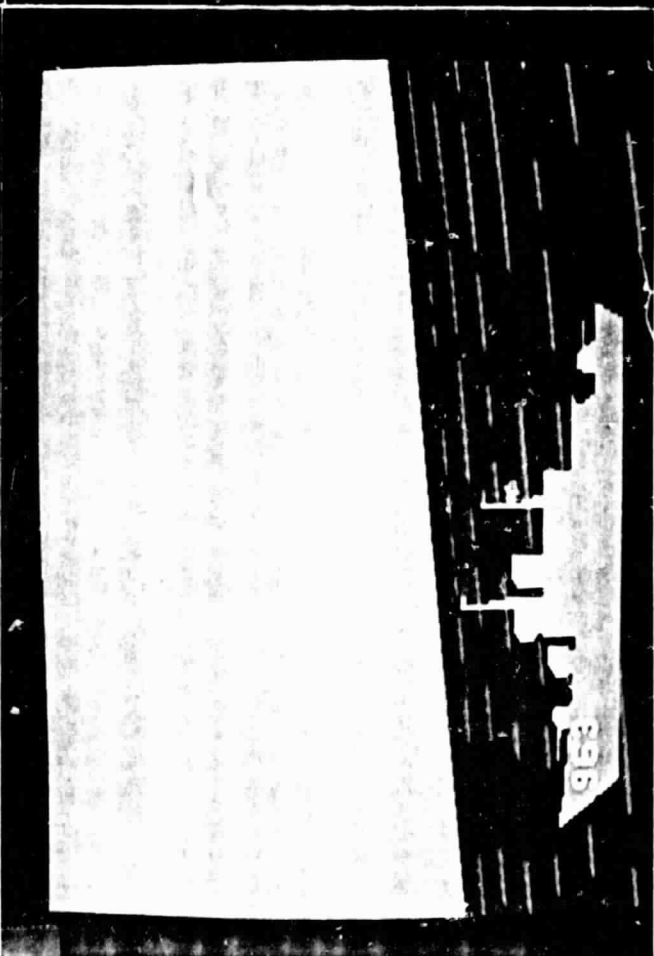
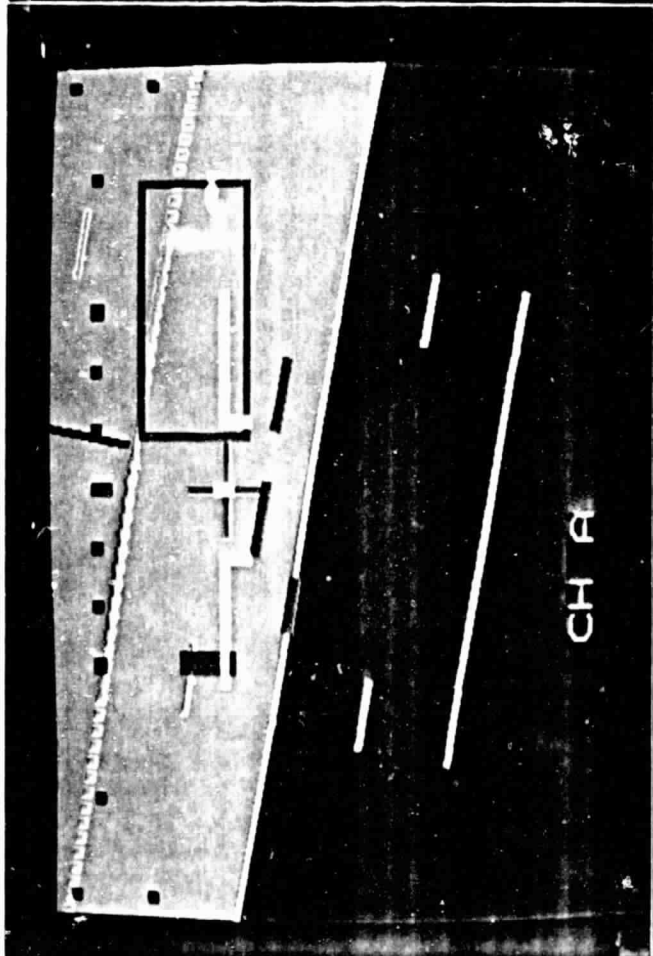
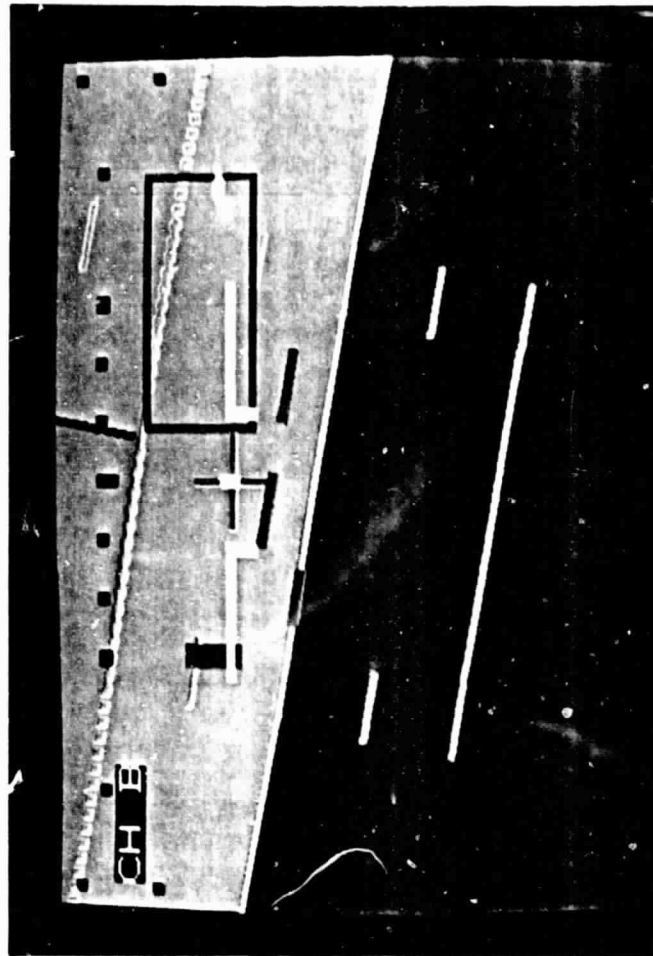
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CHANNEL B

APPENDIX I
INITIALIZED DISPLAYS OF FSDS

CHANNEL A

ORIGINAL PAGE IS
OF POOR QUALITY